Toronto Public Library
Pamphlet Collection

Hydro-Electric Power Commission of Ontario

TORONTO PUBLIC LIBRARY
PAMPHLET COLLECTION

REPORT

ON

THE RATE OF COAL CONSUMPTION IN VARIOUS ELECTRIC GENERATING STATIONS AND INDUSTRIAL ESTABLISHMENTS IN CANADA AND THE UNITED STATES

Toronto, February 15th, 1918

Hydro-Electric Power Commission of Ontario

METROPOLITAN
TORONTO
CENTRAL
LIBRARY
Science and Technology
SC
REF
CIR
SR
REF
CIR

REPORT

ON

THE RATE OF COAL CONSUMPTION IN VARIOUS ELECTRIC GENERATING STATIONS AND INDUSTRIAL ESTABLISHMENTS IN CANADA AND THE UNITED STATES

Toronto, February 15th, 1918

621.31213
0556
1918

MAR 17 1975

REPORT

ON

THE RATE OF COAL CONSUMPTION IN VARIOUS ELECTRIC GENERATING STATIONS AND INDUSTRIAL ESTABLISHMENTS IN CANADA AND THE UNITED STATES

INTRODUCTORY

The basic data for this research have been selected only from those relating to all electric power stations which use coal for fuel and which use it entirely for generating steam.

Special effort has been made to eliminate all factors which would in any wise be irrelevant to the purpose in hand. Thus, all stations which, in part, use wood, oil or fuel other than coal for steam generation; stations using producer gas; or those employed for standby or auxiliary purposes in connection with the production of power by other means, etc., have been disregarded.

A circular letter, accompanied by a list of questions covering matters bearing on the subject, was sent to a number of central stations throughout Canada and the United States, these being chosen with due regard to the restrictions mentioned in the Appendix.

As a result of these enquiries particulars were received from 73 stations, fifty per cent. of the replies being from representative stations ranging in capacity from 150 k.w. to 150,000 k.w. and containing all details necessary for the purposes of this research.

These replies have all been carefully tabulated in the accompanying sheets, most of the figures being averages for the past five years, and the average figures for different sizes of stations have been deduced therefrom.

It will be noted that the tables divide the various stations into "classes" "A" to "F" inclusive. These are purely arbitrary divisions made for convenience and are as follows:—

Table	I	Class	A—Includes stations	up to 1,000 K.W. Capacity.
"	II	"	B— " "	from 1,001 to 5,000 K.W. Capacity.
"	III	"	C— " "	" 5,001 to 10,000 " "
"	IV	"	D— " "	" 10,001 to 50,000 " "
"	V	"	E— " "	" 50,001 to 100,000 " "
"	VI	"	F— " "	above 100,000 K.W. capacity.

Table VII summarizes the average figures for the various "classes" and Table VIII gives averages for groups of "classes," e.g., the first (horizontal) row of figures gives averages for stations in classes A and B, the second row gives them for classes A, B, and C and so on.

In addition to the tables a curve sheet, No. 180206, has been prepared, to accompany this report, which shows the relation of a number of factors to station capacity.

The average figures made use of have therefore been compiled from various stations and cover several years of operation as is shown below:—

Class	No. of Stations	No. of Years Operation	Station Years of Operation	Average size of Station K.W.
" A "	[illegible] 1	5 4	14	650
" B "	8 1 1	5 4 3	47	2980
" C "	7 3 2	5 4 1	49	7250
" D "	6 2	5 3	36	24,600
" E "	1	5	5	96,000
" F "	1	5	5	149,000

Thus the figures are, in effect, based on the operation of the various sizes of stations given in the 5th column of the above table over the periods of time given in the 4th column, and as all the periods of operation are quite recent, it will be seen that the data used constitute a very fair basis to work upon.

Technical Data

(*a*) Central Stations.

The averages of the more important items in Tables I to VI for the various "classes" of stations, are as follows:—

Average Figures per "class"

Class	Station Capacity		Coal					Load Factor	Eff.
			Lbs. per		Tons per		B.T.U. per lb.		
	K.W.	H.P.	K.W.H.	H.P.H.	K.W.Y.	H.P.Y.		%	%
A..........	650	870	7.65	5.70	34.60	25.10	12,500	29.3	3.5
B..........	2,980	4,000	4.30	3.20	19.00	14.00	12,900	34.2	6.2
C..........	7,230	9,700	4.07	3.04	17.80	13.30	11,900	31.7	7.0
....	24,600	33,000	2.91	2.17	12.75	9.52	13,600	36.0	6.6
E..........	96,000	128,300	2.01	1.50	8.80	6.57	14,000	36.9	12.1
F	149,000	199,500	1.92	1.43	8.40	6.26	13,500	44.7	13.1
All Classes	46,340	62,600	3.81	2.84	16.90	12.46	13,600	35.5	8.4

In the foregoing table, "efficiency cent." is the percentage of the efficiency of conversion of heat energy in the coal to electric energy at the switchboard.

The B.T.U. per pound of coal as given in this table have been calculated by taking the B.T.U. for each station, as given in tables I to VI, multiplying these values by the average pounds of coal used per annum by each station, and dividing the sum of the products thus obtained by the total pounds of coal used, per annum, by all the stations in the class. The resulting figures, while they approximate those which would be obtained by simply taking the averages of the B.T.U. as the figures stand in the columns, are yet sufficiently different to warrant the employment of the more accurate method.

In making estimates, the use of a coal of higher or lower calorific value per pound in any given station would of course alter the coal consumption per k.w.h. in a corresponding manner and it is for this reason that these B.T.U. values have been given.

Portions of Table VIII may with advantage be inserted here also:—

Classes	Station Capacity		Coal					Load Factor	Eff.
			Lbs. per		Tons per		B.T.U. per lb.		
	K.W.	H.P.	K.W.H.	H.P.H.	K.W.Y.	H.P.Y.		..	%
A & B....	1,820	2,440	5.97	4.45	26.80	19.55	12,800	31.3	4.8
A to C....	3,620	4,860	5.34	3.98	23.80	17.47	12,250	31.7	5.6
A to D....	8,870	11,890	4.73	3.53	21.04	15.48	13,[illegible]	32.8	6.3
A to F....	46,740	62,650	3.81	2.84	16.90	12.46	13,600	35.5	8.4

These figures will be useful in considering groups of stations, the average capacities of which are of the order of those given in the table; variations of such average capacities from those given may then be allowed for (plus or minus) by consulting Table VII, which gives the highest and lowest of the figures from which the averages in Table VIII have been derived.

Turning now to conditions as they exist in Canada, it is found (from McGraw's Central Station List—1917) that the average capacities of steam driven Central Stations using coal in this country, are approximately as follows:—

—	Average	Total	—	Average	Total
Alberta	1675 K.W.	21775 K.W.	Ontario..............	135 K.W.	4030 K.W.
British Columbia	960 "	6695 "	Prince Edward Island	350 "	700 "
Manitoba........	1060 "	8455 "	Quebec	1570 "	17800 "
New Brunswick..	570 "	4520 "	Saskatchewan	1870 "	16860 "
Nova Scotia	670 "	11390 "		8860 "	92225 "
			Average........	1000 "	for all Canada

From Table VIII it will be observed that for stations in capacities up to 1,800 k.w. the average load factor is 31.3 per cent. so that 30 per cent. for a 1,000 k.w. station will be a fair figure to take in round numbers. The rate of coal consumption of an 1,800 k.w. station will, as may be seen from the same table, average 20 tons per h.p. year and for a 650 k.w. station (see Table VII) averages 25 tons per h.p. year—on this basis a 1,000 k.w. station will average a rate of about 23 tons per h.p. year.

(*b*) Industrial Plants.

The Hydro-Electric Power Commission of Ontario conducted an investigation last year regarding the industrial steam plants in use in the Niagara District and compiled a list of a large number of these, giving various details respecting them. From this list those plants were chosen which, so far as the records show, use coal exclusively and use it for power only (other plants use large quantities of refuse and some employ steam for heating, etc.); these constituted a large proportion of the total number and amounted to 135 actual plants selected.

Averaging the plant capacities in h.p., the tons of coal used per annum, and the number of hours during which the plants operate per day, the following figures were obtained:—

Averages of 135 industrial steam plants:—

H.P.	Tons coal used per year	Daily hours of operation
260	1,830	13.75

The hours of operation are undoubtedly too high for normal times as most factories are working overtime and many operate 24 hours per day.

According to the "Postal Census of Manufactures" covering the year 1915 (page XIV) "each manufacturing establishment in Canada worked full time 222 days" and part time for 19 days, "the average shift consists of 9.2 hours." From this it may be assumed that a fair average figure would be 9.2 × 222 + 5 × 19 = 2,140 or, say, 2,500 hours per annum. At 75 per cent. hourly load factor, which is a reasonable figure to take for such plants and is the same as that used in the 1903 report of the Ontario Power Commission, the rate of coal consumption per h.p. hour works out to $\frac{1830 \times 2000}{260 \times \frac{75}{100} \times 2500} = 7.5$ pounds. For continuous operation (8,760 hours per annum) this is equivalent to $\frac{7.5 \times 8760}{2000}$ = 33.0 tons per h.p. year—this gives a figure comparable with those in the tables accompanying the present report and represents a yearly load factor of 28.5 per cent., say 30 per cent. in round figures. In Canada the combined capacity of all steam driven electric generating stations is close to 100,000 k.w. (134,000 h.p.). See table above.

Dr. Haanel of the Bureau of Mines, Ottawa, in a paper recently read before the Canadian Society of Civil Engineers estimated that "7,000,000 tons were probably required for the purpose of generating power"—this was in speaking of the total fuel requirements of the country during 1916.

On the basis of 33 tons per h.p. year the above quantity would suffice for 210,000 h.p. but this is for 8,760 hours operation; for an average of 2,500 hours the h.p. would be $\frac{8760}{2500} \times 210,000 = 735,000$ h.p., or say in round numbers 750,000 h.p.

)
ge

n
d
n.
se
of
o-

n,
ng

st

15
ne
s.”
+
ad
ns
of

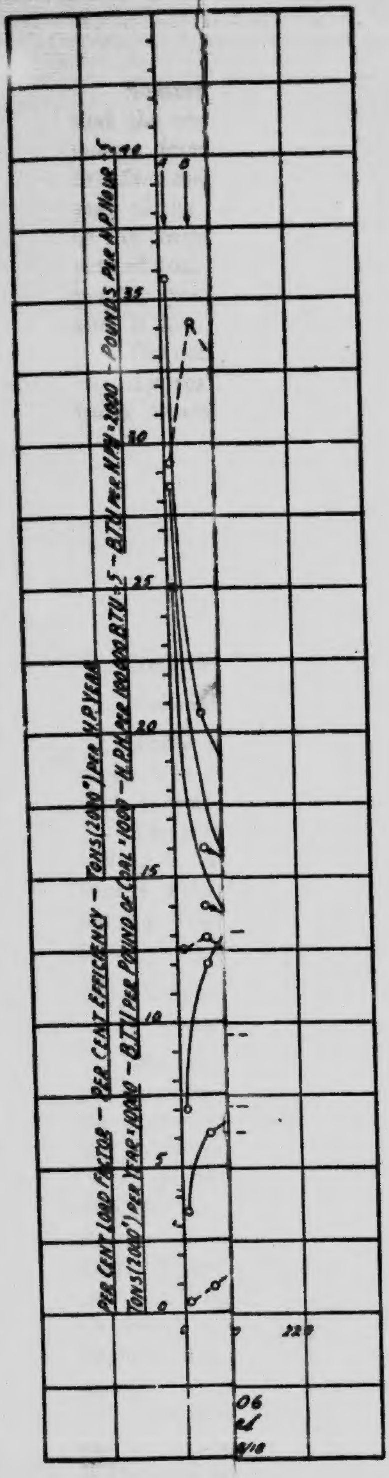
or

30

les
er
all
.).

re
ere
ng

for
urs
ers



pears
their
at of
h.p.
acity
rage
tons
poses

oses,

orm
t of

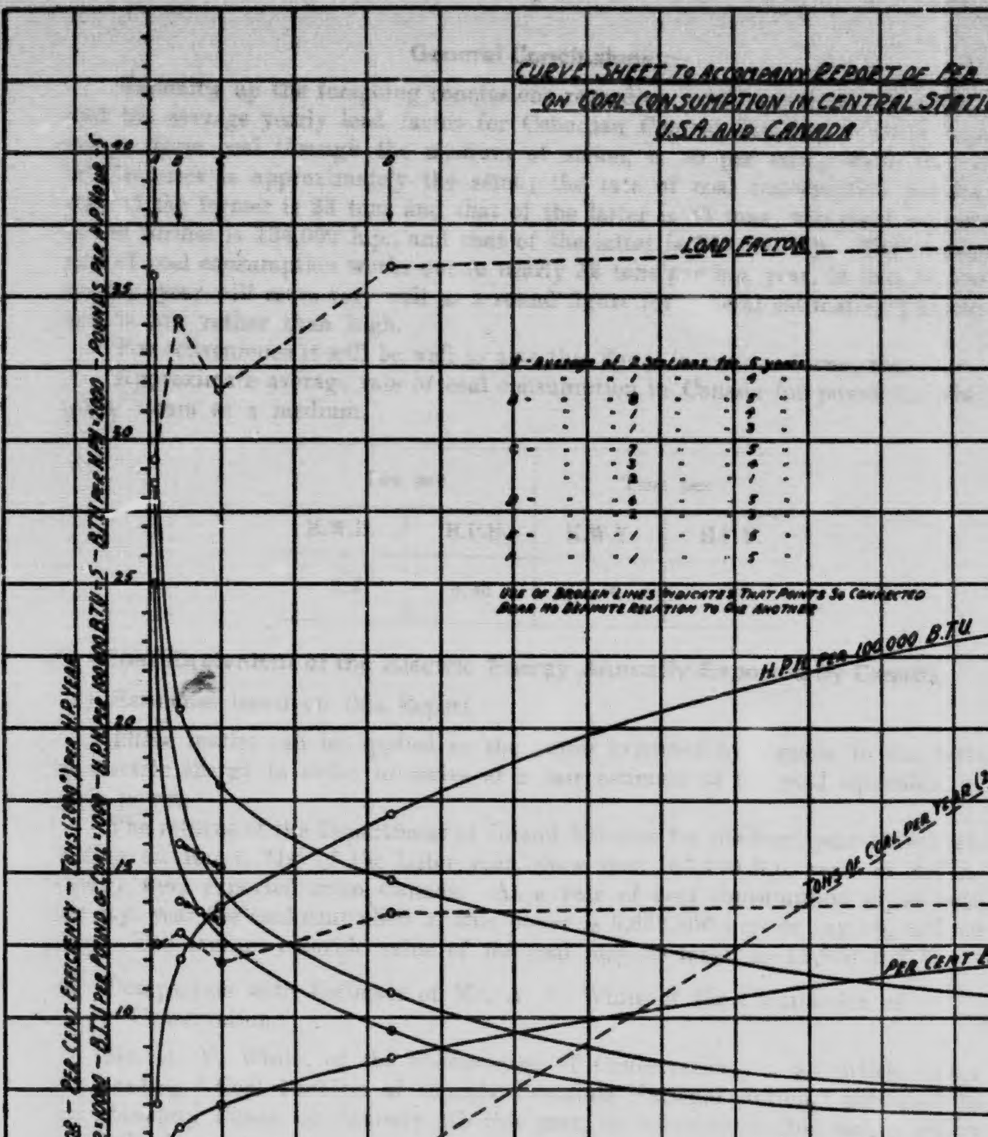
917,
tric
ons
lion

der
in
kes

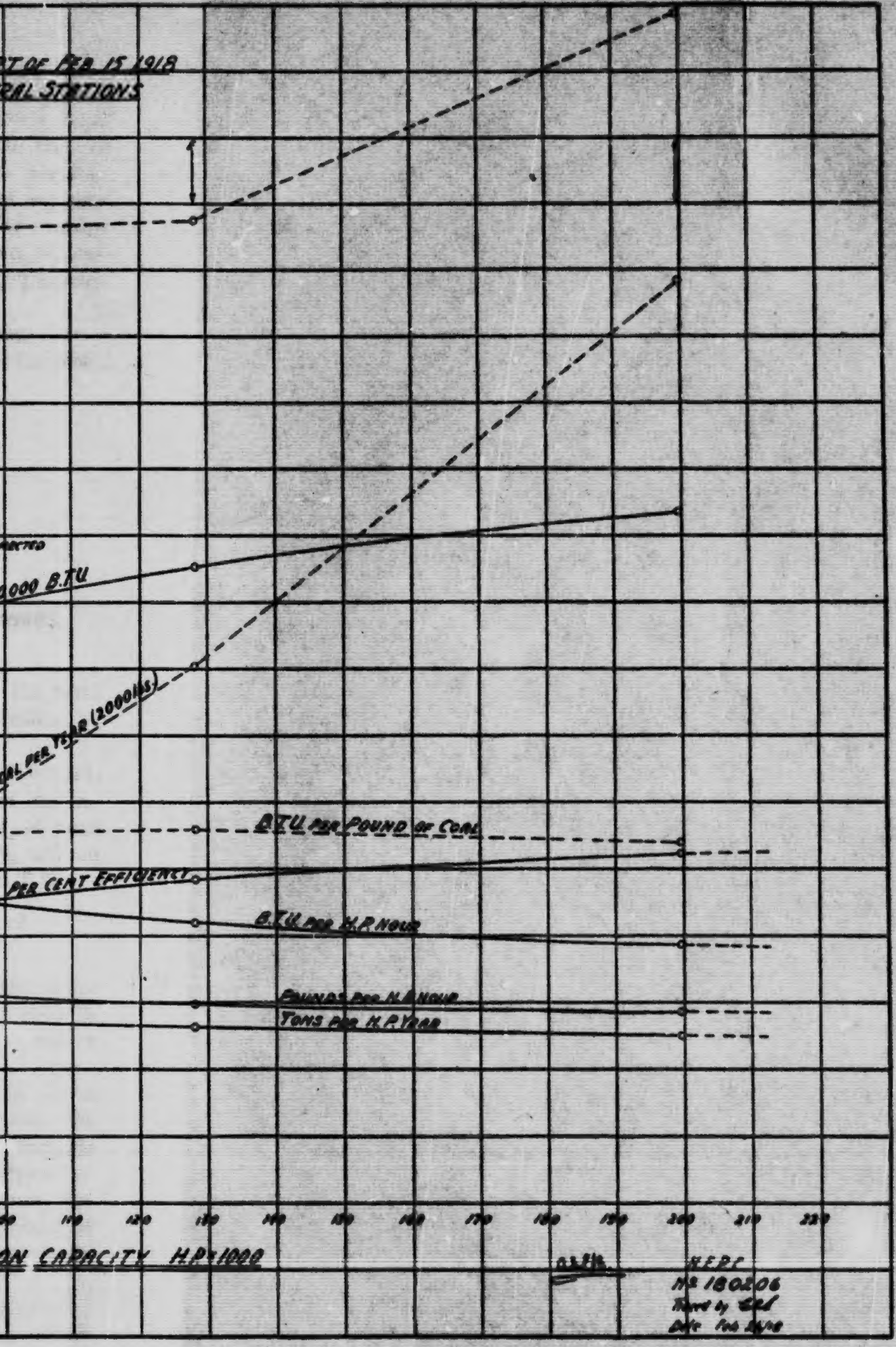
out
the
ite
ing
the
of
lly

ly,
ich
led
he
as

CURVE SHEET I



EET NO. 180206



General Conclusions

Summing up the foregoing conclusions regarding load factors, etc., it appears that the average yearly load factor for Canadian Central Stations deriving their energy from coal through the medium of steam, is 30 per cent., while that of the factories is approximately the same; the rate of coal consumption per h.p. year of the former is 23 tons and that of the latter is 33 tons; the plant capacity of the former is 134,000 h.p., and that of the latter is 750,000 h.p. The average rate of coal consumption works out to nearly 32 tons per h.p. year, so that 30 tons per h.p. year will serve very well as a round figure for general estimating purposes and is low rather than high.

For convenience it will be well to give this figure in various forms, thus:—

Approximate average rate of coal consumption in Canada for power purposes, using steam as a medium.

Lbs. per		Tons per	
K.W.H.	H.P.H.	K.W.Y.	H.P.Y.
9.2	6.85	40	30

Coal Equivalent of the Electric Energy Annually Exported by Canada

(*a*) Estimates based on this Report.

These results can be applied to the power exported by Canada in the form of electric energy in order to arrive at a fair estimate of the coal equivalent of such power.

The returns of the Department of Inland Revenue for the fiscal year 1916-1917, ending on March 31st of the latter year, show that 187,420 h.p. years of electric energy were exported from Canada. At a rate of coal consumption of 30 tons per h.p. year the coal equivalent of this power is 5,622,600 tons or say 5½ million tons. The average calorific value of the coal may be taken as 13,000 B.T.U.

(*b*) Comparison with Estimate of Mr. A. V. White of the Commission of Conservation.

Mr. A. V. White, of the Commission of Conservation, in an article under the heading "Coal Problem of Canada Demands National Action," published in the *Monetary Times,* on January 4th this year, in referring to this matter makes the following statement:—

"At the present time the United States is importing from Canada about 200,000 h.p. years of electrical energy. Many factors, of course, enter into the determination of the equivalent of this electrical power in terms of anthracite coal. Electric power has great advantage for many purposes over steam. Speaking in round figures, and taking cognizance of some of these special factors, the electrical power now imported by the United States would be the equivalent of probably not less than 3,000,000 tons of coal—it may be a quantity substantially greater."

It will be noted that Mr. White here refers to anthracite which has probably, on the average, a somewhat higher calorific value than bituminous coal, which is the kind used in the majority of the cases from which figures have been compiled for this report, and, further, Mr. White has specially drawn attention to the fact that a number of prominent factors govern in making deductions such as have been presented above and states that the quantity may be *substantially* greater than that which he has set down.

There is therefore only an apparent and not a real disagreement between the conclusions of this report and those of Mr. White, more especially as the data in the form now submitted were not available at the time when his paper was written.

The question of load factor, as it affects these figures, requires dealing with in order to clear up any doubt regarding it. The rate of coal consumption, 30 tons per h.p. year, used for the foregoing estimate, is based, as previously shown, on a load factor of 30 per cent., this being a fair average figure for central stations and industrial establishments combined, and it is a fact that, as shown by the records accompanying this report, even in the very largest steam driven stations, where every effort is made to increase the load factor to the highest possible figure, the load factor does not exceed 50 per cent., and in the smaller stations it is usually considerably less: the same remarks apply to industrial establishments. It is true that there are cases of central stations, and factories also, having load factors a good deal higher than 50 per cent., but these are not sufficiently numerous to seriously affect the average figure.

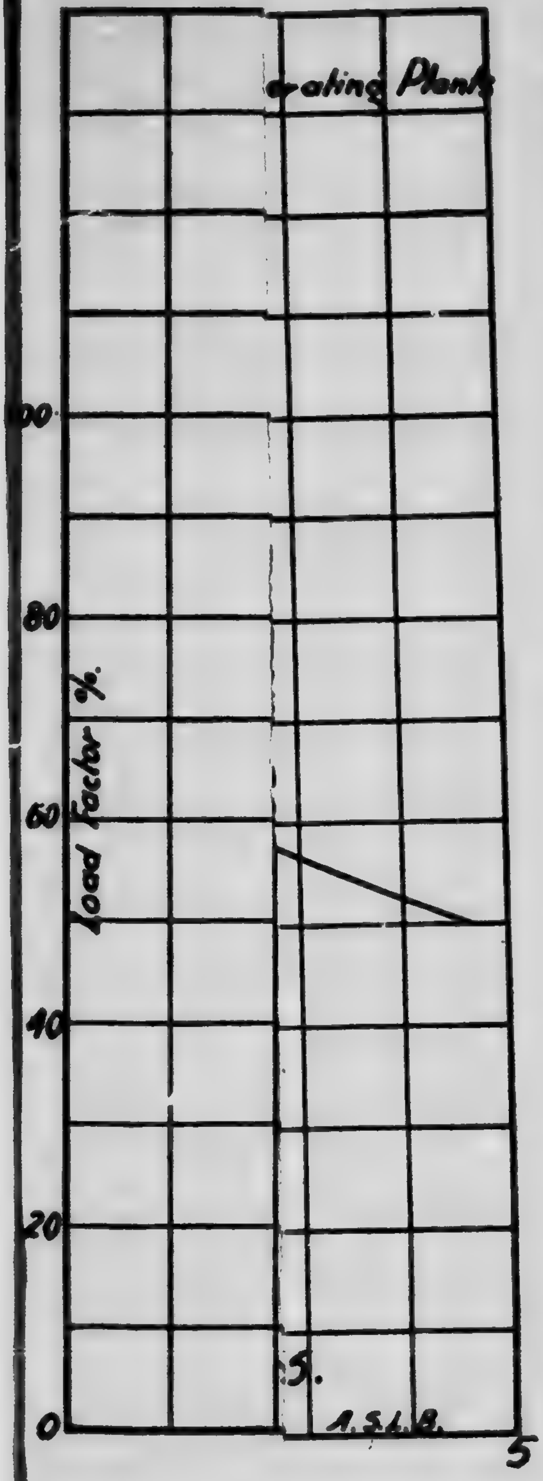
The reason for bringing out this point is that the load factor of the power exported from Canada is known to be somewhere about 85 per cent. or more, and a steam driven station worked at such a load factor would undoubtedly operate on a much lower figure than 30 tons per h.p. year but this is not a correct basis to work on because it has been definitely established that, on the average, Canadian steam driven plants, deriving their energy from coal, do, actually, work on a 30 per cent. load factor, and, since this represents existing conditions, it is the correct figure to use for the purpose to which it has been here applied.

Comparison of Figures Deduced in this Report with those Obtained in Europe

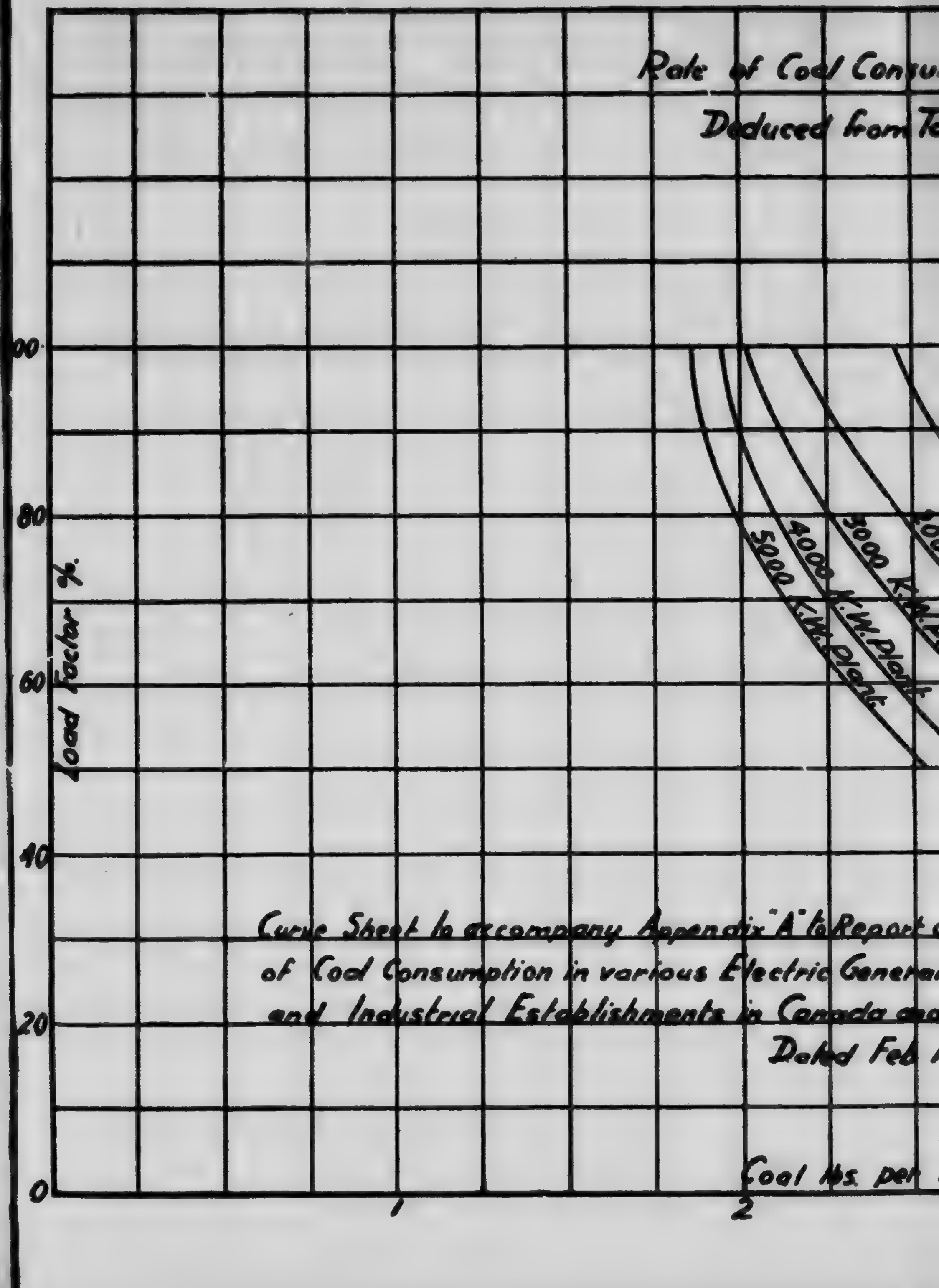
In a report of this nature a comparison of results on this continent with those obtained in Europe is interesting. In the *Journal of the Institution of Electrical Engineers* (England) for January, 1914, is a paper by Professor G. Klingenberg on "Electricity Supply of Large Cities," in which the author gives many data regarding the power stations of Berlin, Chicago and London. Extracts from some of the tables in this paper are given below:—

—	Berlin 1911–12	Chicago 1911	London 1910–11
Population	2,600,000	2,200,000	6,500,000
No. of Stations	6	6	64
Installed capacity (K.W.)	137,000	221,700	298,400
Average sizes (K.W.)	23,000	37,000	4,670
Total Peak Load (K.W)	94,600	190,300	185,500
Peak Load per power station (K.W.)	15,800	31,700	3,900
K.W.H. generated	274,000,000	684,000,900	405,000,000
Distribution of Load per cent—			
Lighting	24	19	61
Power	45	12	27
Traction	31	69	12
Load Factor %	33.1	41.0	24.9
* Coal per K.W.H. generated (lbs.)	2.6	3.3	4.1
* Efficiency of energy conversion % approx.	9.8	7.7	6.2

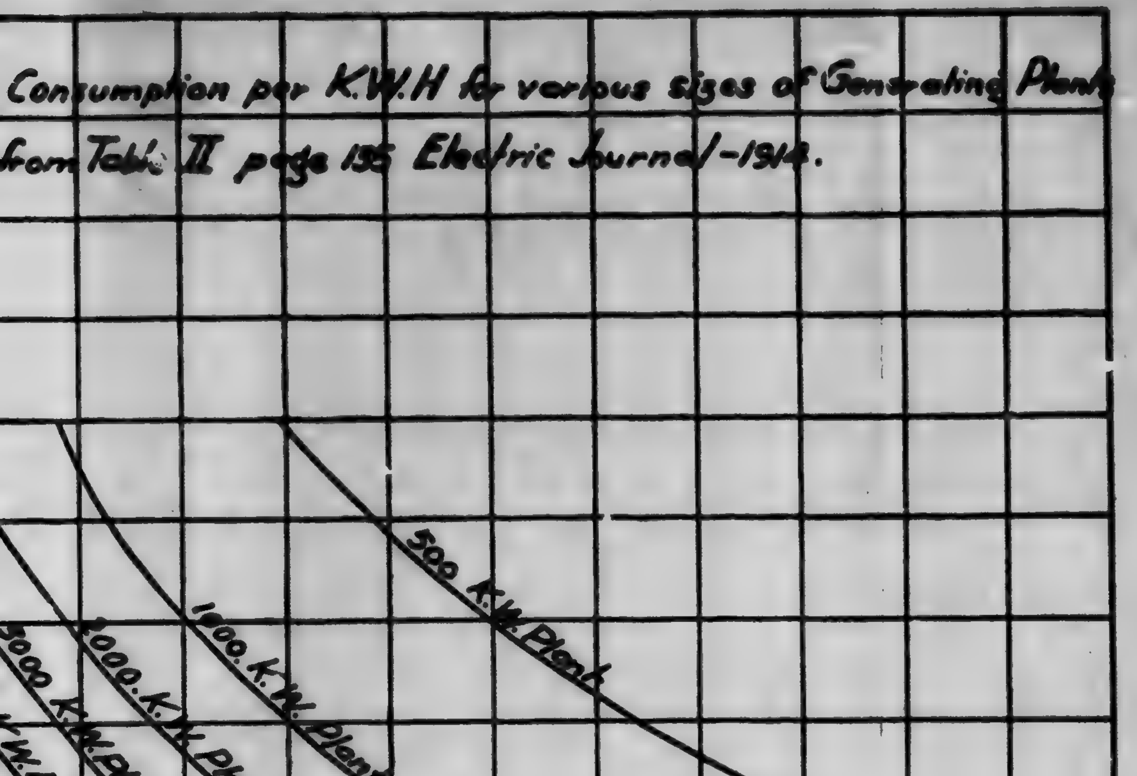
*N.B.—Figures in this row are changed to refer to English units instead of metric and to K.W.H. generated instead of sold, as they stand in the original tables. The last row of figures has been calculated on the basis of an assumed value of 13,500 B.T.U. per lb.


rating Plants
Load Factor %.
100
80
60
40
20
0
S.
A.S.L.B.
5

CURVE SHEET


Rate of Coal Consu
Deduced from To
100
80
60
40
20
0
Load Factor %.
5000 K.W. Plant
4000 K.W. Plant
3000 K.W. P
Curve Sheet to accompany Appendix "A" to Report o
of Coal Consumption in various Electric Genera
and Industrial Establishments in Canada and
Dated Feb
Coal lbs. per
1
2

HEET NO. 180216



Comparison of the foregoing tabulation with Table VII of this report corroborates the figures of the latter if due allowance be made for various possible disturbing elements such as calorific value of the fuel used (which is not given in Professor Klingenberg's paper), varying load factors, differing equipment in the various stations considered, etc., although the Berlin stations show a decidedly better result than the others, which the author states is offset (so far as cost is concerned) by the appreciably higher prices for coal in that city. These prices are: Berlin 17.41, Chicago approximately 8, and London approximately 12.8 shillings per ton.

Summary

So far as coal consumption is concerned the foregoing may be briefly summed up as follows:—

For electric generating stations, using coal fired under boilers, such as are in actual operation in Canada and the United States to-day, the average rates of coal consumption for various sizes of stations are as shown below:—

Station Capacity K.W.	Rate of Coal Consumption Tons per H.P.Y.
Over 100,000	6.25
50,000 to 100,000	6.57
10,000 to 50,000	9.32
5,000 to 10,000	13.30
1,000 to 5,000	14.00
Under 1,000	25.10 and higher

Now, although it is true that, under very favourable conditions and in plants of the largest sizes, the rate of coal consumption may be as low as 6.25 tons per h.p. year, it is equally correct to state that, taking average existing conditions for electric generating stations in Canada, the rate approximates to 23 tons per h.p. year, and, for industrial plants, to 33 tons per h.p. year, while for these two kinds of plants combined, the average rate is not less than 30 tons per h.p. year.

APPENDIX "A"

There is an interesting feature of the Curve Sheet No. 180206 which is worthy of notice:—

The curve of coal consumption per h.p. year becomes practically horizontal at a station capacity of about 150,000 h.p., showing that with present equipment, methods of operation, load factors, etc., in the large generating stations, the rate of coal consumption cannot come below about 6.25 tons per h.p. year, no matter how large a station may be. Since the equipment now in use is getting near to the maximum possible efficiency this means that probably under no circumstances will it be possible to get below, say 5.5 tons per h.p. year. Centralization on a vast scale may tend to reduce costs but cannot conserve coal very much as compared with existing conditions in the large stations. At the same time it must be remembered that as the coal bill in a central station usually forms from 40 per cent. to 60 per cent. of the total costs, even comparatively small percentage savings on this item count for a good deal in actual money.

Another point to be observed from the curves is, that, comparing stations of say 50,000 h.p. and 200,000 h.p. capacity respectively, it is found that the rates of coal consumption are 8.6 and 6.26 tons per h.p. year, showing a saving of approximately 25 per cent. for the larger station; the respective load factors are, however, 36.2 per cent. and 44.7 per cent. respectively, and there is no doubt that if the smaller stations were operated at the same load factor as that obtained in the larger station the difference in the rates of coal consumption would be much smaller than that given above (excluding other disturbing factors such as the use of poor coal), and emphasizes the fact that the very large stations do not tend to make very big reductions in rates of coal consumption as compared with those of more moderate size.

It is evident from these considerations that coal can be better conserved by appreciably increasing the load factors of existing stations of moderate size (around 50,000 k.w. capacity) than by building huge stations having only slightly higher load factors than those of the smaller sizes.

This is clearly indicated by Curve Sheet No. 180216, accompanying this Appendix, which shows the rate of coal consumption in various sizes of plants at different load factors. The rate of coal consumption at a given load factor as the plants become larger, is reduced but at a rapidly decreasing rate, and, though the same is true of the rate at different load factors for the same plant, it is not in so great a degree.

The tables and other data incorporated here, together with the figures deduced therefrom will no doubt be of use in other directions than the one in which they have been applied in this report.

Figures have been mostly worked out by slide rule and all references to "tons" mean "short" tons of 2,000 pounds each.

Referring to tables VII and VIII, it will be noted that the average load factors, rates of coal consumption and other items which are derived from the figures given in the first four columns of figures, do not check properly if calculated directly from the figures in these first four columns.

The reason for this is that, as may be seen by referring to Tables I to VI, the averages of each item have been deduced by adding together the figures in the various columns and dividing by the number of sets of figures in each column.

For example, take the averages of all classes, "A" to "F" in Table VIII, the figures in the columns of load factor, rates of coal consumption, etc., are averaged as indicated above.

Different results would have been obtained, say, for tons of coal per k.w. year, if the average tons per class, had been added together and divided by the sum of the average kilowatt years per class—the figure thus obtained would have been lower than that shown on account of the preponderating influence of the large number of k.w. hours for the larger stations.

By using the method of calculation which has actually been adopted this preponderating influence is removed and the averages approximate those which would be obtained were the aggregate capacities and outputs of the stations in each class equal.

For the purposes of this report this method is the better.

APPENDIX "B"

The Coal Conservation Sub-committee of the Re-construction Committee of Great Britain presented to Parliament on April 17th, 1917, an Interim Report on "Electric Power Supply in Great Britain," of which the following extracts contain points of interest in connection with this report.

"The coal consumption involved in the production of motive power in the United Kingdom amounts at the present time to 80,000,000 tons per annum"

(89,600,000 short tons) "equivalent in value to say £40,000,000 at pit head" ($2.23 per short ton).

"If power supply in the United Kingdom were dealt with on comprehensive lines and advantage taken of the most modern engineering development, the saving in coal throughout the country would in the near future, amount to 55,000,000 tons per annum" (61,600,000 short tons) "on the present output of manufactured products."

"Taking the value of this coal for export purposes at 10s. per ton" ($2.23 per short ton), "the national annual advantage of the change, available for interest on capital, is, say, £27,500,000" ($137,500,000) "in coal alone. Alternately if this 55,000,000 tons of coal were used for extended and new industrial processes, some 15 million horse-power continuously throughout the year would be available for the purpose."

"This saving of £27,500,000 per annum takes no account of the following additional and important advantages which would directly result from the establishment of an efficient electric power supply system throughout the country:—

"1. A reduction in the cost of transport in carrying coal.

"2. A possible saving in coal consumption for domestic purposes, (the consumption for which purpose is now probably 35 million tons (39 million short tons) per annum.

"3. The reduction in the cost of coal handling involved in house-to-house delivery and general coal distribution.

"4. The great advantages and economies which would result from the more extended use of electricity in the household for heating, cooking and cleaning purposes in the way of labour saving devices, reduction of smoke, increased cleanliness, etc.

"5. The possibility, referred to in paragraph 20 (3), of utilizing the coal at present left in the pits or otherwise wasted.

"6. The possibility of extracting by-products, etc., before consuming the coal for power purposes.

"7. The increase in railway electrification with its attendant advantages which a comprehensive electric supply system would render commercially possible and profitable.

"All these savings and advantages taken together show a total possible national advantage which can hardly be put at less than £100,000,000 per annum, apart from the manufacturing and industrial advantages of a cheap and efficient electric power supply."

"Power may be most efficiently applied to industry by the medium of electricity."

"The average coal consumption per horse-power-hour throughout the country has been halved during the last 25 years. In spite of this the total amount used has increased. But the present coal consumption would if used economically, produce at least three times the present amount of power."

"The question which has been settled conclusively during the past 15 years is that the most economical means of applying power to industry is the electric motor, which, on account of its high efficiency, has ruled out all rivals so far as the workshop itself is concerned. In the factories put down for the production of munitions during the war, 95 per cent. of the machinery is driven by means of electricity, and it is only a question of time for all power to be applied in this way."

The foregoing extracts have been made to emphasize the views of this British Committee on two points specially:—

1. The enormous waste of coal which takes place when it is burned in small isolated plants instead of in large central stations.

2. The great advantages resulting from the use of electric energy in industries, in the home and for transportation purposes.

APPENDIX "C"

The Presidential address at the A. I. E. E. convention held in New York, on Feb. 15th, 1918, by E. W. Rice, Jr., was on "Railway Electrification as a Means of Saving Fuel and Relieving Freight Congestion."

The salient points of this address were:—

"Where electricity has been substituted for steam in the operation of railroads, fully 50 per cent. increase in available capacity of existing tracks and other facilities has been demonstrated.

"This increased capacity has been due to a variety of causes, but largely to the increased reliability and capacity, under all conditions of service, of electric locomotives, thus permitting a speeding of train schedules by some 25 per cent. under average conditions. Of course, under the paralyzing conditions which prevail in extremely cold weather when the steam locomotives practically go out of business, the electric locomotives make an even better showing."

"It is estimated that something like 150,000,000 tons of coal were consumed by the railroads in the year 1917. Now we know from the results obtained from such electrical operation of railroads as we already have in this country that it would be possible to save at least two-thirds of this coal if electric locomotives were substituted for the present steam locomotives. On this basis there would be a saving of over 100,000,000 tons of coal in one year."

". . . the useful or revenue carrying capacity of our steam roads could be increased about 10 per cent., with existing track facilities, by eliminating the entire company coal movement."

"I have not mentioned the consumption of oil by the railroads which, we are told, amounted in 1915 to something like 40,000,000 barrels."

"It is estimated that there is not less than 25,000,000 h.p. of water power available in the United States, and if this were developed and could be used in driving railroads, each horse-power so used would save at least 6 pounds of coal per horse-power-hour now burned under the boilers of our steam locomotives. It is really terrifying to realize that 25 per cent. of the total amount of coal which we are digging from the earth each year is burned to operate our railroads under such inefficient conditions that an average of at least six pounds of coal is required per horse-power-hour of work performed.

"The same amount of coal burned in a modern central power station would produce an equivalent of three times that amount of power in the motors of an electric locomotive even including all the losses of generation and transmission from the source of power to the locomotive.

"Where water power may be utilized—all of the coal used for steam locomotives can be saved."

Comment on the foregoing seems unnecessary since incontrovertible facts are given.

DATA RE COAL CON

Class " A "—Stations up t

Question No.		1	2	3	4	5			6	7	8
Class No.	Ref. No.	Station Capacity in K.W.	Average Max. K.W. per year for 1912-3-4-5-6	Average K. W. H. Gen. per year for 1912-3-4-5-6	Average Coal tons per year 1912-3-4-5-6	Nature of Load			Approx. Age of Plant Years	Kind of Stoking	Kind of Draft
						Lighting	Power	Railway			
" A "	62	800	367	1,133,800	4,100	61%	35%	4%	3-4	Hand	Natural ....
" A "	170	150	55	124,800	546	Yes	Yes	No	9	Hand	Natural ....
" A "	60	1,000	853	2,112,800	7,154	Yes	Yes	No	6	Hand	Natural ....
Totals..	....	1,950	1,275	3,371,400	11,800	....	....	....	....	....	....
Approx. averages		650	425	1,123,820	3,930	....	....	....	....	....	....

Class " B "—Stations 1,001

Question No.		1	2	3	4	5			6	7	8
Class No.	Ref. No.	Station Capacity in K.W.	Average Max. K.W. per year for 1912-3-4-5-6	Average K.W.H. Gen. per year 1912-3-4-5-6	Average Coal Tons per year 1912-3-4-5-6	Nature of Load			Approx. Age of Plant Years	Kind of Stoking	Kind of Draft
						Lighting	Power	Railway			
" B "	111	3,500	2,280	3,112,756	14,606	46%	54%	None	Modern	Mech.	Mech ....
" B "	?	4,500	1,960	4,187,628	9,018	60%	40%	None	5	Mech	Mech ....
" B "	190	1,500	1,233	3,585,082	7,702	Yes	Yes	None	15	Hand	Natural ....
" B "	172	2,450	707	2,748,648	4,760	Yes	Yes	None	Modern	Hand	Natural ....
" B "	216	3,000	1,405	4,083,176	12,444	Yes	Yes	None	4–5	Mech.	Mech. ....
" B "	86	2,700	956	3,062,278	7,856	Yes	Yes	None	Modern	Mech.	Mech ....
" B "	113	2,000	704	2,181,326	5,068	Yes	Yes	None	Modern	Mech.	Mech ....
" B "	197	2,200	1,156	3,314,150	9,218	Yes	Yes	Yes	Modern	Mech.	Mech ....
" B "	155	2,925	1,960	3,354,578	5,748	Yes	Yes	Yes	Modern	Hand	Natural ....
" B "	184	5,000	3,200	12,500,500	16,250	Yes	Yes	Yes	1½	Mech.	Natural ....
Totals..	....	29,775	15,650	47,034,567	92,255	....	....	....	....	....	....
Approx. averages		2,980	1,570	4,703,600	9,230	....	....	....	....	....	....

Class " C "—Stations 5001 to

Question No.		1	2	3	4	5			6	7	8
Class No.	Ref. No.	Station Capacity in K.W.	Average Max. K.W. per year for 1912-3-4-5-6	Average K.W.H. Gen. per year 1912-3-4-5-6	Average Coal Tons per year 1912-3-4-5-6	Nature of Load			Approx. Age of Plant Years	Kind of Stoking	Kind of Draft
						Lighting	Power	Railway			
" C ".....	96	5,250	1,520	6,471,166	16,265	25%	60%	15%	Modern	Mech.........	Natural ....
" C ".....	22	10,000	5,226	14,180,960	17,100	?	?	?	Modern	Mech.........	Mech..........
" C ".....	?	9,225	4,350	12,212,228	17,783	55%	45%	None	17	Mech.........	Natural ....
" C ".....	68	10,000	3,650	9,818,462	17,721	Yes	Yes	Yes	Modern	Mech.........	Natural ....
" C ".....	84	5,695	3,216	10,898,660	20,278	Yes	Yes	None	Part 20 .... Part 10	Hand and Mech	Natural ....
" C ".....	183	8,000	3,900	8,628,400	12,166	Yes	Nearly all	None	2	Mech.........	Natural ....

TABLE I

L CONSUMPTION IN CENTRAL STATIONS

tions up to 1,000 K.W. Capacity. N.B.—Tons, 2,000 lbs.

8	9	10	11	12	13	14	15	16	Coal		
ad f ft	Kind of Prime Movers	Condensing or Non-Cond.	Operation Daily Hours	Grade of Coal	Coal Field	Coal Average B.T.U.	Abnormal Conditions	General Remarks	Av. Ann. Load Factor %	Lbs. per H.P. Hour	Tons per H.P. Year
	2 Engines 1 Turbine	Engines N.C. Turbine C.	24	Nut and Slack	Pittsburgh and Kanawha River	14,000 13,000		4 years only	33.4	5.30	23.65
	Engines	N. C	24	Slack	Colorado	About 12,000			25.6	6.55	29.50
	Turbines	C	24	No. 4,5,6, Screen.	Indiana	About 12,000			29.0	5.06	22.15
									85.0	17.0	75.30
									28.3	5.70	25.10

TABLE II

ons 1,001 to 5,000 K.W. Capacity. N.B.—Tons, 2,000 lbs.

	9	10	11	12	13	14	15	16	Coal			
ad f aft	Kind of Prime Movers	Condensing or Non-Cond.	Operation Daily Hours	Grade of Coal	Coal Field	Coal Average B.T.U.	Abnormal Conditions	General Remarks	Av. Ann. Load Factor %	Lbs. per H.P. Hour	Tons per H.P. Year	
	Turbines	C	24	Bituminous Slack	Lucerne, Pa.	14,000			40.6	2.72	11.92	
	2 Engines 2 Turbines	C	24	Nut, Slack and Mine Run	West Va. & Ky.	14,000			24.4	3.22	14.13	Source unk
	Turbines	C	24	Youghiougheny Screenings	Pa.	About 15,000			33.2	3.21	14.10	
	Turbines	C	24	Bituminous	New River and Kanawha	About 14,000		4 years only	44.4	2.41	10.57	
	Turbines	C	24	Lignite	Alberta	10,000		Recon. 1913. Poor economy then.	30.8	4.58	20.10	Note—
	Engines & Turbines	C	24	Mine Run	Penn ?	13,500			36.6	3.58	15.70	
	Turbines	C	24	Slack	East Penn. ?	14,000			34.5	3.55	15.52	
	2 Engines 1 Turbine	C	24	Mine Run, Lignite	Alberta ?	9,000		3 years only	32.7	4.16	18.45	Note—
	Engines & Turbine	C	24	?	Sommerset Jenner	14,000			19.6	2.52	11.06	
	Turbines	C	24	Bitumin. Slack	Fairmount, W.Va.	13,250			44.6	1.94	8.50	
									341.4	31.89	140.0	
									34.2	3.20	14.0	

TABLE III

s 5001 to 10000 K.W. Capacity. N.B.—Tons, 2,000 lbs.

	9	10	11	12	13	14	15	16	Coal			
d ft	Kind of Prime Movers	Condensing or Non-Cond.	Operation Daily Hours	Grade of Coal	Coal Field	Coal Average B.T.U.	Abnormal Conditions	General Remarks	Av. Ann. Load Factor %	Lbs. per H.P. Hour	Tons per H.P. Year	
	2 Engines, 2 Turbines	C 1 Engine N.C	24	Bituminous	Alabama	12,000			48.6	3.75	16.45	
	Turbines	C	24	Bituminous	Pocahontas	14,500			30.9	1.80	7.91	
	Engines and Turbines	C	24	?	?	14,500			32.1	2.16	9.47	Source know
	Turbines	C	24	Screenings	S. Illinois	10,000		4 years only	30.7	2.69	11.80	Note—
	Engines and Turbines	N.C	24	Screenings	Alabama	13,000		1 year only	38.6	2.78	12.40	
	Turbines	C	24	Nut and Slack	W. Va	14,250		1 year only	24.2	2.10	9.23	

16 Coal

ions	General Remarks	Av. Ann. Load Factor %	Lbs. per H.P. Hour	Tons per H.P. Year	Remarks
.....	4 years only....	30.4	5.39	23.65	
.....	....	25.6	6.55	28.50	
.....	....	29.0	5.06	22.15	
.....	....	85.0	17.0	75.80	
.....	....	28.3	5.70	25.10	

16 Coal

ions	General Remarks	Av. Ann. Load Factor %	Lbs. per H.P. Hour	Tons per H.P. Year	Remarks
.....	....	40.6	2.72	11.92	
.....	....	24.4	3.22	14.13	Source of information unknown
.....	....	33.2	3.21	14.10	
.....	4 years only..	44.4	2.41	10.57	
.....	Recon. 1913. Poor economy then.	30.8	4.58	20.10	Note—Lignite used
.....	....	36.6	3.58	15.70	
.....	....	34.5	3.55	15.52	
.....	3 years only	32.7	4.16	18.45	Note—Lignite used
.....	....	19.6	2.52	11.05	
.....	....	44.6	1.94	8.50	
.....	....	341.4	31.89	140.0	
.....	....	34.2	3.20	14.0	

16 Coal

ions	General Remarks	Av. Ann. Load Factor %	Lbs. per H.P. Hour	Tons per H.P. Year	Remarks
.....	....	48.6	3.75	16.45	
.....	....	30.9	1.80	7.91	
.....	....	32.1	2.16	9.47	Source of information unknown.
.....	4 years only....	30.7	2.69	11.80	Note—Poor coal.
.....	1 year only	38.6	2.78	12.40	
.....	1 year only	24.2	2.10	9.23	

						Lighting	Power	Railway				
" C ".....	96	5,250	1,530	6,471,168	16,265	25%	60%	15%	Modern	Mech.........	Natural........	2 Engines, Turbine
" C ".....	22	10,000	5,226	14,183,960	17,100	?	?	?	Modern	Mech.........	Mech...........	Turbines .
" C ".....	?	9,225	4,360	12,213,228	17,733	55%	45%	None	17	Mech.........	Natural........	Engines a Turbine
" C ".....	66	10,000	3,650	9,515,462	17,721	Yes	Yes	Yes	Modern	Mech.........	Natural........	Turbines .
" C ".....	34	5,606	3,216	10,598,650	20,278	Yes	Yes	None	Part 20 .... Part 10	Hand and Mech	Natural........	Engines a Turbine
" C ".....	188	8,000	3,900	8,628,400	12,106	Yes	Nearly all	None	2	Mech.........	Natural........	Turbines .
" C ".....	105	8,500	5,286	10,223,954	24,111	20%	20%	60%	½-16 ½- 8	Mech.........	Mech...........	Engines a Turbine
" C ".....	158	6,000	3,316	4,998,695	13,340	45%	55%	None	Modern	Hand.........	Mech...........	Turbines .
" C ".....	218	5,950	3,082	8,969,838	19,275	40%	39%	21%	Modern	Mech.........	Mech...........	Engines a Turbine
" C ".....	41	5,110	4,848	14,630,192	34,787	Yes	Yes	Yes	Engines 15.. Turbines 7	Mech.........	Natural........	Engines a Turbine
" C ".....	217	6,000	3,170	8,065,649	15,189	Yes	Yes	Yes	1 old station 1 new "	Hand and Mech	Natural & Mech.	Engines a Turbine
" C ".....	40	,900	4,280	10,116,026	33,794	Yes	Yes	Yes	11	Mech.........	Mech...........	Turbines..
Totals..	....	86,750	45,864	125,052,212	241,759	....	....	....	....	....	....	....
Approx. averages		7,230	3,830	10,422,000	20,200	....	....	....	....	....	....	....

Class "D"—Stations, 10,001 to 50,

Question No.		1	2	3	4	5			6	7	8	9
Class No.	Ref. No.	Station Capacity in K.W.	Average Max. K.W. per year for 1912-3-4-5-6	Average K.W.H. Gen. per year 1912-3-4-5-6	Average Coal Tons per year 1912-3-4-5-6	Nature of Load			Approx. Age of Plant Years	Kind of Stoking	Kind of Draft	Kind of Prime Movers
						Lighting	Power	Railway				
"D"......	89	37,000	4,248	8,702,572	13,852	Yes	Yes	Yes	Modern	Mech.........	Mech...........	Turbines .
"D"......	19	32,000	20,000	51,060,400	56,535	25%	70%	5%	Quite Mod..	Mech.........	Mech...........	Turbines .
"D"......	66	11,500	6,900	27,807,860	57,249	Yes	Yes	Yes	Modern	Mech.........	Natural........	Turbines .
"D"......	92	32,000	8,540	26,935,535	30,897	Yes	Yes	None	7	Mech.........	Mech...........	Turbines .
"D"......	11	15,000	7,600	30,069,363	34,743	Yes	Yes	None	8	Mech.........	Mech...........	Turbines .
"D"......	179 A	27,500	11,920	46,172,700	64,917	72%	72%	28%	Modern	Mech.........	Natural........	Turbines .
"D"......	179 B	20,800	11,858	19,302,744	29,445	65%	65%	35%	Part 17.... Part Mod.	Mech.........	Natural........	Engines a Turbine
"D"......	20	20,850	14,970	57,939,000	96,611	28%	37%	35%	1-18	Mech.........	Mech...........	Engines a Turbine
Totals..	....	196,650	86,036	267,990,174	384,249	....	....	....	....	....	....	....
Approx. averages		24,600	10,760	33,500,000	48,080	....	....	....	....	....	....	....

Class "E"—Stations 50

" E ".....	6	96,000	62,060	200,679,750	201,420	94%	94%	6%	Modern.....	Mech.........	Natural & Mech.	Turbines .

Class " F "—Stations

" F ".....	4	140,000	92,080	360,218,044	345,586	Yes	Yes	Yes	Modern.....	Mech.........	Mech...........	Turbines .

COAL CONSUMPTIO

Average F

Class		Station Capacity	Maximum Load	KWH & HPH Generated	KWY and HPY Generated	I F
A.........	KW H.P	650 870	425 570	1,128,820 1,500,000	128 172	 ...
B.........	KW H P	2,980 4,000	1,570 2,100	4,708,600 6,300,000	538 720	 ...
C.........	KW H P	7,230 9,700	3,820 5,100	10,422,000 14,000,000	1,190 1,600	 ...

2 Engines, 2 Turbines	C 1 Engine N.C	24	Bituminous	Alabama	12,000	....	....	48.6	3.75	16.45	
Turbines ...	C	24	Bituminous	Pocahontas	14,500	....	....	30.9	1.80	7.91	
Engines and Turbines	C	24	?	?	14,500	....	....	32.1	2.16	9.47	Source of in known.
Turbines ...	C	24	Screenings	S. Illinois	10,000	....	4 years only....	30.7	2.69	11.80	Note—Poor
Engines and Turbines	N.C	24	Screenings	Alabama	,000	....	1 year only	33.6	2.78	12.40	
Turbines ...	C	24	Nut and Slack..	W. Va..........	14,250	....	1 year only	24.2	2.10	9.23	
Engines and Turbines	C	24	Jenner and New River	Penn	14,000	....	....	35.0	2.22	9.74	
Turbines ...	C	24	Anthracite	?	11,000	....	....	17.2	4.46	19.58	
Engines and Turbines	N.C	24	Lignite.........	Western Canada	9,570	....	4 years only....	33.4	3.23	14.17	Note—Poor densing Pl
Engines and Turbines	C	24	Bituminous Slack	South Colorado.	11,000	Paralleled with another plant part time	4 years only....	34.4	3.54	15.50	
Engines and Turbines	C	24	Bituminous	Alberta	12,750	Old Plant in use 1912-14. New Plant since	....	29.0	2.76	12.12	
Turbines....	C	24	Slack & Mine Run	Colorado	9,200	....	....	26.5	4.95	21.80	
....	....	....	....	....	....	....	....	380.6	36.44	160.17	
....	....	....	....	....	....	....	....	31.7	3.04	13.50	

TABLE IV

01 to 50,000 K.W. Capacity. N.B.—Tons, 2,000 lbs.

9	10	11	12	13	14	15	16	Coal			
Kind of Prime Movers	Condensing or Non-Cond.	Operation Daily Hours	Grade of Coal	Field	Coal Average B. T. U.	Abnormal Conditions	General Remarks	Av. Ann. Load Factor %	Lbs. pe. H.P. Hour	Tons per H.P. Year	
Turbines ...	C	24	Bituminous	Penn	14,400	....	....	23.2	2.38	10.42	
Turbines ...	C	24	?	New River and Penn.	13,750	....	....	28.3	1.66	7.26	
Turbines ...	C	24	Screenings......	Indiana	11,500	....	....	45.7	3.07	13.45	Poor Coal
Turbines ...	C	24	Bituminous.....	Penn	14,200	....	....	37.0	1.71	7.50	
Turbines ...	C	24	Bituminous.....	W. Va. and Ohio.	14,000	....	3 years only	45.1	1.72	7.55	
Turbines ...	C	24	Bituminous ..... Nut and Slack	New River and Pocahontas	14,000	....	....	44.1	2.10	9.20	
Engines and Turbines	C	24	Bituminous..... Nut and Slack	New River and Pocahontas	14,000	Operates with Hydro. Plant	....	19.7	2.27	9.96	
Engines and Turbine	C	24	Nut, Pea, Slack and Mine Run	Ohio and W. Va.	14,000	....	3 years only	44.0	2.48	10.87	
....	....	....	....	....	....	....	....	287.1	17.39	76.21	
....	....	....	....	....	....	....	....	36.0	2.17	9.52	

TABLE V

tations 50,001 to 100,000 K.W. Capacity

Turbines ...	C	24	Bituminous.....	New River, W.Va.	14,000	....	....	36.9	1.50	6.57

TABLE VI

–Stations over 100,000 K.W. Capacity

Turbines ...	C	24	Mine Run.......	W.Va., E. Ky., O.	13,500	....	Combined figures for 2 stations.	44.7	1.43	6.26

TABLE VII

UMPTION OF CENTRAL STATIONS

Average Figures (By Slide Rule)

VY and HPY enerated	% Load Factor	Lbs. per KWH & HPH	Tons per KWY & HPY	Coal		Consumption Tons per year (2,000 lbs)	KWH and HPH per 100,000 Btu.	Eff. %
				Btu per KWH and HPH	Btu per lb.			
128 172	20.8	7.65 5.70	34.00 25.00	95,600 71,400	12,500	3,980	1.04 1.40	3.5 ....
538 720	34.2	4.30 3.20	19.00 14.00	55,500 41,300	12,900	9,280	1.80 2.40	6.2 ....
1,190 1,600	31.7	4.07 3.04	17.80 13.30	48,500 36,200	11,900	20,200	2.06 2.76	7.0 ....

ns	General Remarks	Av. Ann. Load Factor %	Lbs. per H.P. Hour	Tons per H.P. Year	Remarks
....	....	48.6	3.75	16.45	
....	....	30.9	1.80	7.91	
....	....	32.1	2.16	9.47	Source of information unknown.
....	4 years only....	30.7	2.69	11.20	Note—Poor coal.
....	1 year only	38.0	2.78	12.40	
....	1 year only	34.2	2.10	9.23	
. .	....	35.0	2.22	9.74	
....	....	17.2	4.46	19.58	
....	4 years only....	28.4	3.23	14.17	Note—Poor coal. No Condensing Plant.
other	4 years only,...	34.4	3.54	15.50	
2-14.	....	29.0	2.76	12.12	
... .	....	28.5	4.96	21.80	
....	....	380.6	36.44	160.17	
....	....	31.7	3.04	13.50	

16 Coal

ons	General Remarks	Av. Ann. Load Factor %	Lbs. per H.P. Hour	Tons per H.P. Year	Remarks
.....	....	23.2	2.38	10.42	
.....	....	28.8	1.66	7.26	
.....	....	45.7	3.07	13.45	Poor Coal
.....	....	37.0	1.71	7.50	
.....	3 years only	45.1	1.72	7.55	
....	....	44.1	2.10	9.20	
dro.	....	19.7	2.27	9.96	
......	3 years only	44.0	2.48	10.87	
.....	....	287.1	17.39	76.21	
.....	....	36.0	2.17	9.52	

....	....	36.9	1.50	6.57	

....	Combined figures for 2 stations.	44.7	1.43	6.26	

Class "E"—Stations

"E".....	6	96,000	62,000	200,679,750	201,420	94%	94%	6%	Modern.....	Mech.........	Natural & Mech.	Turbines

Class "F"—Station

"F".....	4	149,000	92,000	360,218,044	345,586	Yes	Yes	Yes	Modern.....	Mech.........	Mech...........	Turbines

COAL CONSUMPTI

Average

Class		Station Capacity	Maximum Load	KWH & HPH Generated	KWY and HPY Generated
A........	KW	650	425	1,123,820	128
	H.P	870	570	1,500,000	172
B........	KW	2,980	1,570	4,708,600	538
	H P	4,000	2,100	6,300,000	720
C........	KW	7,230	3,820	10,422,000	1,190
	H.P	9,700	5,100	14,000,000	1,600
D........	KW	24,600	10,760	33,500,000	3,820
	H P	33,000	14,400	44,900,000	5,120
E........	KW	96,000	62,000	200,679,750	23,050
	H P	128,800	83,000	276,500,000	31,650
F........	KW	140,000	92,000	360,218,000	41,000
	H.P	190,500	123,290	488,000,000	55,000

AVERAGES

A & B...	KW	1,820	1,000	2,918,700	330
	H P	2,440	1,340	3,900,000	440
A to C...	KW	3,620	1,940	5,416,500	620
	H P	4,860	2,600	7,270,000	830
A to D...	KW	8,870	4,150	12,437,300	1,420
	H P	11,890	5,540	16,675,300	1,900
A to F...	KW	46,740	28,440	101,774,500	11,720
	H P	62,650	38,060	137,700,000	15,710

Stations 50,001 to 100,000 K.W. Capacity

n.	Turbines ...	C	24	Bituminous.....	New River, W.Va.	14,000	....	....	36.9	1.50	6.57

TABLE VI

—Stations over 100,000 K.W. Capacity

.	Turbines ...	C	24	Mine Run.......	W.Va., E. Ky., O.	13,500	....	Combined figures for 2 stations.	44.7	1.43	6.26

TABLE VII

SUMPTION OF CENTRAL STATIONS

Average Figures (By Slide Rule)

KWY and HPY Generated	% Load Factor	lbs. per KWH & HPH	Tons per KWY & HPY	Coal		Consumption Tons per year (2,000 lbs)	KWH and HPH per 100,000 Btu.	Eff. %
				Btu per KWH and HPH	Btu per lb.			
128 172	29.8	7.65 5.70	34.60 25.00	95,600 71,400	12,500	3,980	1.04 1.40	3.5 ....
588 720	34.2	4.30 3.20	19.00 14.00	55,500 41,300	12,900	9,230	1.80 2.40	6.2 ....
1,190 1,600	31.7	4.07 3.04	17.80 13.30	48,500 36,200	11,900	20,200	2.06 2.76	7.0 ....
3,820 5,120	36.0	2.90 2.17	12.75 9.50	39,600 29,500	13,600	48,030	2.50 3.40	8.6 ....
23,650 31,650	36.9	2.00 1.50	8.80 6.57	28,000 21,000	14,000	201,420	3.57 4.76	12.1 ....
41,000 55,000	44.7	1.92 1.43	8.40 6.26	25,900 19,300	13,500	345,580	3.86 5.18	13.1 ....

TABLE VIII

AVERAGES OF GROUPS OF CLASSES

330 440	31.3	5.97 4.4[illegible]	[illegible] [illegible]	75,560 56,350	12,800	6,580	1.35 1.77	4.8 ....
620 880	31.7	5.34 3.98	[illegible] [illegible]	66,540 49,630	12,250	11,120	1.50 2.01	5.6 ....
1,420 1,900	32.8	4.73 3.53	21.04 15.48	59,800 44,600	13,100	29,350	1.67 2.25	6.8 ....
11,720 15,710	35.5	3.81 2.84	16.90 12.46	48,880 36,620	13,600	104,740	2.04 2.78	8.4 ....

....	....	36.9	1.50	6.57	
....	Combined figures for 2 stations.	44.7	1.48	6.26	

4	3	2	1		Station No.
Average Cu	Average K.W. hr [illegible] per year for 1912-[illegible]	Average Max. K.W. per year for 1912-[illegible]	Station Capacity K.W.	No.	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		Totals
[illegible]	[illegible]	[illegible]	[illegible]		Average [illegible]

4	3	2	1		[illegible]
[illegible]	[illegible]	Average Max. K.W. per year for 1912-[illegible]	Station Capacity K.W.	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
[illegible]		[illegible]	[illegible]		[illegible]